Advanced Teleoperation Interfaces at NASA Ames

In order to enable joint human-robot inspection, maintenance, assembly and other critical in-space and surface activities, the Computational Sciences Division at NASA Ames Research Center develops easy-to-use tools for efficient, robust vehicle teleoperation in unknown and unstructured environments, in collaboration with the Robotics Institute (Carnegie Mellon University) and the Virtual Reality and Active Interfaces Group (Swiss Federal Institute of Technology).

Collaborative Control

Since 2000, we have been developing a new human-robot interaction model, collaborative control, which is based on human-robot dialogue. Instead of a supervisor dictating to a subordinate, the human and the robot converse to exchange information, to ask questions, and to resolve differences. With this approach, human-robot interaction is more natural, balanced, and direct than conventional approaches. With collaborative control, the human functions as a resource for the robot. In particular, the robot is allowed to ask the human questions as it works, to obtain assistance with perception and cognition. For example, the robot might ask "Based on this image, it is safe to drive forward?". This allows the human to compensate for limited autonomy, but does not force him to dedicate continuous attention to the robot.

Visual Gestures and Haptics

GestureDriver (2000) is a remote driving interface based on visual gesturing. Hand motions are tracked with a color and stereo vision system and classified into gestures using a simple geometric model. The gestures are then mapped into motion commands, which are transmitted to the robot for execution. HapticDriver (2000) uses force-feedback to improve precision driving, such as required for maneuvering in cluttered spaces or when approaching a docking target. Information from a robot's range sensors is transformed to spatial forces using a linear model and then displayed with a large-workspace haptic hand controller (the Delta Haptic Device). In essence, this enables the user to feel the remote environment.

Advanced Teleoperation Interfaces

Non-Invasive Human-Robot Interfaces

Non-invasive interfaces enable humans to more naturally communicate with robots in proximity and in the course of long-distance interaction. Research success in this regard includes both voice-based interaction and dialogue management as well as indirect muscular sensing using electromyographic techniques that do not require physical contact between sensors, which can be sewn into EVA suits for instance, and Astronaut operators.

Relevance to Exploration Systems

The advanced teleoperation interfaces capabilities at NASA Ames provide enabling technologies for critical joint human-robot tasks to be performed.

H&RT Program Elements:

This research capability supports the following H&RT program /elements:

ASTP/Software, Intelligent Systems & Modeling

ASTP/Computing, Communications, Electronics & Imaging

TMP/Advanced Space Platforms & Systems

TMP/Advanced Space Operations

TMP/Lunar and Planetary Surface Operations

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